

JPRS 76120

28 July 1980

USSR Report

ENGINEERING AND EQUIPMENT

No. 70

FBIS

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NUCLEAR ENERGY

UDC 621.039.51

APPLICATION OF THE THEORY OF PERTURBATIONS TO AN ANALYSIS OF ENGINEERING-PHYSICAL CHARACTERISTICS OF NUCLEAR POWER PLANTS

Moscow ATOMNAYA ENERGIYA in Russian Vol 48, No 4, Apr 80 pp 238-242 manuscript received 21 Jan 79

PUPKO, V. YA. and ZRODNIKOV, A. V.

[Abstract] A nuclear power plant is taken as a unit containing all functional components necessary for operation, including the assembly of fuel elements as well as the reactor vessel and the heat exchanger. The dynamics of physical processes can be described by a mathematical model, i.e., an equation approximately relating an output characteristic and an input characteristic, both measurable as functions of time, through differential or integral operators with lumped a priori given parameters. Here determination of the correct model is seen as an ill-conditioned problem in mathematical physics and is solved as an identification problem by using the variation of a linear functional of the output characteristic, according to the theory of perturbations, as the measure of discrepancy between model and experiment. An algorithm is constructed accordingly which yields an adequate model with respect to minimum dispersion. It involves calculation of the inverse Green's function and allows for the use of a functional most adequate for a given noise level in the signal detector. In engineering application the procedure is reversible: transient processes can be calculated according to a model, and parameters of the model can be refined on the basis of test data. This is illustrated in a typical case of heat balance between fuel element and heat carrier. Figures 2; tables 1; references 11 Russian.

[70-2415]

TEMPERATURE DEPENDENCE OF PERFORMANCE CHARACTERISTICS OF DIRECT-CHARGING DETECTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 48, No 4, Apr 80 pp 256-258 manuscript received 23 Apr 79; after final revision 14 Sep 79

MITEL'MAN, M. G., KONONOVICH, A. A., OSIPOV, V. M. and ROZENBLYUM, N. D.

[Abstract] Direct-charging detectors used inside reactors for inspection are generally stable at temperatures up to 700°C, but in some cases their sensitivity has been found to depend on the ambient temperature. An experimental study of this dependence was made at the Institute of Atomic Energy imeni I. V. Kurchatov. A DPZ-1 detector, with a 150 mm long rhodium emitter, was placed inside a 500 mm long cylindrical electric heater within the core of the power reactor. Another identical DPZ-1 detector was placed 40 mm away, for monitoring the stability of the neutron flux. Detector currents were measured with a) the chromel wire only, b) the alumel wire only, c) both wires of a chromel-alumel thermocouple for measuring the emitter temperature connected to the detector. The reactor temperature was varied and stabilized over the 300-700°C range. The data on the temperature dependence of detector readings and on the variation of emitter temperature, insulation resistance and detector current with time indicate that, as the temperature rises, the current readings obtained with different thermocouple connections will differ. In each case the current increases to a maximum and then slowly decreases, stabilizing much later than the temperature. The insulation resistance decreases and the current stabilization time increases with rising temperature, with the current possibly stabilizing below its level in a cold heater. A fast temperature drop causes the current to drop and the insulation resistance to rise, to respectively below and above their respective initial levels. A theoretical analysis of space charge and current relations in the dielectric layer indicates that the temperature stability of the detector performance can be improved by reducing the thickness of the layer and the attenuation of beta particles, also by increasing the electrical conductivity of the dielectric and decreasing its temperature coefficient. Figures 2; tables 1; references 7: 4 Russian, 3 Western.

[70-2415]

UDC 538.56

ELECTROMAGNETIC FIELDS EXCITED BY NEUTRONS IN AIR

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 29-39 manuscript received 3 Aug 78

MEDVEDEV, YU. A. and METELKIN, YE. V., Moscow

[Abstract] The unsteady space-energy distribution of fast neutrons slowing down in air is considered with the object of computing the space-time distribution of the sources of secondary gamma-radiation initiated by neutrons in the air. It is shown that knowledge of the neutron distribution function can serve to compute the sources of secondary gamma-radiation describing the number of gamma-quanta emitted by nuclei per time unit and per volume unit as a result of interaction with neutrons. On this basis, the solution of a simplified model problem of the electromagnetic fields excited by an unsteady source of neutrons as well as by instantaneous gamma radiation is considered. It is concluded that allowance for the gamma radiation forming in the air owing to interaction between >3 MeV neutrons and nuclei of nitrogen and oxygen accounts for the formation of radio pulses that agree in duration and shape with their observed counterparts. Figures 8; references 17: 13 Russian, 4 Western.

[62-1386]

UDC 533.95:538.4+533.9:621.039.61

EFFECT OF MAGNETIC FIELD MAGNITUDE ON THE DECELERATION OF ALPHA PARTICLES

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 40-46 manuscript received 27 Nov 78

GAYSINSKIY, I. M., KALININ, A. V. and STEPANOV, A. YE., Moscow

[Abstract] Laser fusion reactors utilizing magnetic fields for cavity wall protection attract increasing attention. The principle on which they are based is that of using the magnetic field to slow down high-energy alpha-particles to thermal velocities. In this connection, the physical processes of the interaction between the thermonuclear alpha-particles and the axial magnetic field are investigated in theory, by considering the magnetohydrodynamic model of the expansion of a plasma envelope consisting of thermonuclear alpha-particles with 2-3 MeV energies and electrons in an axial magnetic field with the induction $B_0 \leq 0.5$ T. Problems associated with the

development of Rayleigh-Taylor instability in the equatorial cross section of the plasmoid are examined. It is shown that at the plasma envelope-magnetic field interface, perturbations arise that result in disintegration of the plasmoid and total deceleration of alpha-particles when the field induction is increased to 0.75 T. These findings are of value in the design of hybrid laser fusion reactors with cylindrical geometry. Figures 6; references 8: 7 Russian, 1 Western.

[62-1386]

NON-NUCLEAR ENERGY

UDC 621.316.98.001.5

TECHNIQUES FOR INFLUENCING THE ORIENTATION OF LONG-SPARK DISCHARGES

Minsk IZVESTIYA VUZov: ENERGETIKA in Russian No 2, 1980 pp 18-24 manuscript received 12 Jun 78

ALEKSANDROV, G. N., IVANOV, V. L., KADZOV, G. D. and KURILOV, V. A., Lenin-grad Order of Lenin Polytechnical Institute imeni M. I. Kalinin

[Abstract] Fields of side discharges (concentrated or bulk) introduced into the discharge gap are investigated as a way of influencing the orientation of long-spark discharges. From the theoretical standpoint, the problem reduces to evaluating the effect of the fields of side discharges on the capture zone. It is shown that the probability of the incidence of discharges in the field attenuation zone is lower, and hence attenuation of the field in the neighborhood of an object in the presence of a side discharge of the same polarity is a way of reducing the susceptibility of the object. The condition for the existence of an attenuated field zone in the neighborhood of the grounded electrode is formulated. Since the orientation of long-spark discharges and natural lightning discharges follows the same laws, the conclusions can be extended to practical protection of objects and structures such as seagoing vessels and ground structures against damage by lightning. Protection of aircraft against damage by lightning is best assured by utilizing the discharge-displacement effect. Figures 4; references 3 Russian. [75-1386]

UDC 621.165.62-57.011.56

MONITORING AND OPTIMIZATION OF THE HEATING OF HEAVY-DUTY STEAM TURBINES ON
THE BASIS OF MEAN TEMPERATURE DIFFERENCE

Minsk IZVESTIYA VUZov: ENERGETIKA in Russian No 2, 1980 pp 37-43 manuscript
received 13 Nov 78

POKHORILER, V. L. and POMORTSEVA, A. A., Ural Polytechnic Institute imeni
S. M. Kirov

[Abstract] Considering that the direct measurement of thermal stresses in turbines while in operation is extremely difficult, measurement of metal temperatures or of their differences can be used as a yardstick for determining these stresses, especially during the start-up of modern steam turbines. Corresponding formulas for effective temperature difference of walls heated at one surface and insulated at the other during the heating of turbine rotors are presented. On their basis, it is possible to construct a measuring device for the solution of the problem of the optimization of the heating of turbine components as a function of such factors as the mean temperature, the heat transfer coefficient, and the temperature of the heated surface. It is shown how allowance can be made for the presence of stress concentrators. Block diagrams of the designs of corresponding devices for the monitoring and optimization of the start-up modes of steam turbines are presented. Operating trials of these devices show that, since the instantaneous steam temperature is used as one of the inputs, the sharp variation in that input can be offset by means of a smoothing filter. Figures 2; references 7 Russian.

[75-1386]

INDUSTRIAL TECHNOLOGY

UDC [621.313.126:622].004.68

MODERNIZATION OF TE8-320-75 TYPE EXCITER UNDER HIGH-VIBRATION CONDITIONS

Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 3, 1980 p 18

POLLER, YE. V. and MALYAVIN, B. YA., Lebedin Mining and Concentrating Combine

[Abstract] At the Lebedin Mining and Concentrating Combine industrial water is supplied by 24NDS type pumps. During start-up of these pumps the vibration level in rooms containing thyristor excitors (of the TE8-320-75 type) reaches 120-130 d² at frequencies of 16-500 Hz. These vibrations spread to the armature of the electromagnetic relay, thus resulting in premature excitation of the pump motor stator and hence also in automatic disconnection of the motor. In this connection a device for maintaining the pump stator in the excited mode regardless of the vibration level has been developed and adopted. A wiring diagram of the device is presented: its principal components include a rectifier bridge, a capacitor, and a potentiometer. The device is so designed that a decrease in stator current to a level equal to twice the rated current intensity of the motor triggers an automatic command excitation. Updated excitors incorporating devices of this kind have been in operation since 1976. The noncontacting principle that is the basis of the device for maintaining excitation as a function of stator current can be also utilized in excitors of other series and types. Figure 1.
[73-1386]

A ROTOR VOLTAGE CONTROL RELAY FOR A SLIP-RING MOTOR

Moscow PRIMYSHLENNAYA ENERGETIKA in Russian No 3, Mar 80 pp 22-23

KOVAL'CHUK, YE. S., engineer, Belenergorennaladka (expansion not given)

[Abstract] A recent development for starting slip-ring induction motors is the use of resistive-inductive networks instead of rheostats. This starting system is simpler, smooth, more reliable and eliminates contact elements. After the rotor winding has been connected to the RL system, the voltage is applied to the stator. As the rotor builds up speed, the frequency and voltage decrease, and there is a reduction in the influence of the inductive reactance of the starting circuit. When the required voltage is reached, the winding is switched to an asynchronous-rectifier stage. The author describes a special relay for keeping track of the rotor voltage so that switching takes place at the proper time. Such a relay must operate over a wide frequency range (from a fraction of a Hertz to 50 Hz) and at voltages from tens of volts to 1000 V. The proposed device is based on a sensitive polar relay with the winding connected to a rectifier bridge. The rotor voltage goes to the bridge through a current-limiting resistor. A stabistor protects the relay winding from high currents that arise in the initial starting period. Relay contact vibration is prevented by a capacitor connected across the relay leads to smooth out pulsations in the rectified voltage. Design recommendations are given. Figures 2.

[73-6610]

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

UDC 533.6.011.8

THE CONDITIONS OF FORMATION OF A POPULATION INVERSION OF ATOMIC LEVELS IN A THERMALLY HEATED RECOMBINING PLASMA

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 91-97 manuscript received 8 Aug 78

SMEKHOV, G. D. and POTIYEV, V. A., Moscow

[Abstract] A study is made of a plasma consisting of a monatomic gas made up of neutral atoms, singly charged ions and free electrons. The plasma is quasineutral and is initially in the state of complete thermodynamic equilibrium with slight ionization. An analytic estimate is presented of the conditions of operation of a plasma-dynamic laser based on such a gas, which flows through a flat, wedge-shaped nozzle, selected so as to increase the length of the active zone along the nozzle without increasing the mass consumption and provide more effective radiation yield perpendicular to the plane of the nozzle. The results enable estimation of the permissible limits of the range of change of the parameters which influence the operation of the laser. The development of a population inversion of electron levels of atoms in a moving recombining plasma occurs over a rather narrow range of parameters, determined both by the properties of the fluid and the characteristics of the nozzle. Figures 2; references 14 Russian.

[66-6508]

UDC 681.7.064.42:535.241.15

TEMPERATURE DEPENDENCE OF OPTICAL DENSITY OF NEUTRAL ABSORPTION LIGHT FILTERS

Leningrad OPTIKO-MECHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp
8-9 manuscript received 23 Oct 78

MARTYNYUK, A. S.

[Abstract] Neutral light filters are widely used in metrology. This use requires study and consideration of the effect of various factors which determine the error of reproduction of the nominal value of a measurand, especially temperature. This problem is studied in this article based on the following assumptions: the variation of attenuation of radiation by the absorption filter with temperature is formed by the combined action of two mechanisms: thermal expansion of the gas, causing a decrease in the concentration of the dye with increasing temperature, and the variation of the index of absorption of the dye with temperature. One interesting result of this study is the establishment of a strong variation in the temperature coefficient (with a change of sign) as a function of radiation wavelength. The linear model of temperature characteristics is found to be correct for variation of temperature over several tens of degrees Celcius. The concentration of thermal expansion is small. Due to the great variation in absorption as a function of wavelength, the spectral characteristics are not isomorphic at different temperatures. The temperature error of neutral light filters is therefore significant, even for just a few degrees of temperature change. Figure 1; references 3 Russian.

[74-6508]

UDC 621.378.325

DISTRIBUTION OF ENERGY AT THE FOCAL POINT FOR A LIGHT BEAM WITH AN AMPLITUDE WHICH CHANGES ACCORDING TO A NORMAL DISTRIBUTION

Leningrad OPTIKO-MECHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 p 10
manuscript received 5 Dec 78

KULIKOV, V. YE. and KULIKOVSKAYA, N. I.

[Abstract] The results of analysis of the distribution of energy at the focal point of a laser for the central spot and the next three maxima are calculated, using known equations and presented in a table. The calculations were performed by computer by the method of numerical integration. The

positions of the maxima and minima are presented in optical units. It is found that the gaussian distribution of amplitude in the diaphragm expands the central spot and decreases the secondary maxima. References 3: 1 Russian, 2 Western.

[74-6508]

UDC 535.853-1:535.232.61

A SPECTRORADIOMETRIC INSTALLATION FOR INVESTIGATION OF IR RADIATION RECEIVERS

Leningrad OPTIKO-MECHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 13-15 manuscript received 1 Mar 79

UKHANOV, YE. V., TAGANOV, O. K. and LEBEDEVA, L. P.

[Abstract] This article studies the problem of improvement of the hardware and methods of determination of the spectral sensitivity of IR radiation receivers. The installation and method of measurement are based on the use of a metal photometric sphere, the use of which in the IR band has been limited by a number of difficulties related primarily to selection of the material and the technology of its finishing. A modernized pyrometric installation was used to measure the scattering indices of flat specimens of duralumin alloy sand blasted with quartz sand. The results of the study showed as expected that the device developed does not vary in spectral sensitivity with varying wavelength in the IR band studied. Figures 3; references 6 Russian.
[74-6508]

UDC 621.384.326

AN AIRBORNE THERMOGRAPH WITH CIRCULAR SCANNING OF THE BEAM

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 15-17 manuscript received 5 Mar 79

BABAYEV, A. A.

[Abstract] A radiant energy receiver with a beam which scans along the generatrix of a cone has been developed for highly sensitive airborne thermography of the surface of the earth. When it is used, the scan angle made between the beam and the surface of the earth remains unchanged in the process of scanning. The characteristics of the device are calculated, including the spacing between neighboring lines on the surface of the earth scanned by the circular beam. The device consists of two mirrors, an optical element and a radiation receiver. Accumulation of the signal due to successive scanning of points on the terrain in several passes and addition of their signals through a delay circuit using a light receiver with 3 X 2 square areas permits practically continuous scanning of the surface and superimposition of scanned strips, with some increase in sensitivity. Figures 3; references 2 Russian.

[74-6508]

UDC 621.378.32:548

SPECIFICS OF THE APPLICATION OF A RUBY FOR MANUFACTURE OF THE ACTIVE ELEMENTS OF A SINGLE-MODE LASER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 20-23 manuscript received 5 Apr 79

DANILOV, S. V., DOVGER, L. S., KOROLEV, YE. A., PRILEZHAYEV, D. S., SEDOV, B. M. and YAGMEROV, V. KH.

[Abstract] A study of ruby laser elements was performed on the basis of a single-mode, single-pulse GOM-1 ruby laser with a 3-power telescope installed before the amplifier. A ruby element with leukosapphire tips was used, with one end beveled at 89°. The laser and amplifier are described, and photographs are presented of distorted wave fronts produced in the measurements. It was found that crystals subjected to vacuum annealing at 1980-2040°C produced greater amplification, although the reason is not known. The effect of bubbles in the laser medium on radiation strength was studied. In

general, it was found that lasers grown by the Czochralski method from a melt are superior optical elements for the manufacture of lasers, but rubies grown by the Verneuil method may also be used quite successfully. Figures 3; references 7: 5 Russian, 2 Western.
[74-6508]

UDC 535.234

INFLUENCE OF THE RESIDUAL GAS PRESSURE ON OPTICAL PROPERTIES OF THIN FILMS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 25-28 manuscript received 17 Aug 78

PANASENKO, B. V., NESMELOV, YE. A. and TAGIROV, R. B.

[Abstract] The problem of the influence of the depth of vacuum on the optical and structural properties of thin films produced by evaporation is quite interesting. To study this problem, an installation was used which could produce a film-application vacuum of about $5 \cdot 10^{-7}$ mm Hg, to produce films of metal fluorides and sulfides. Primary attention was given to yttrium fluoride films. The growth rate of the film was maintained constant in the experiments. It was found that vacuum depth has a significant influence on film properties. Yttrium fluoride films applied at residual gas pressures on the order of $5 \cdot 10^{-5}$ mm Hg have maximum porosity. Absorption in the films outside of the adsorbate absorption bands does not change with a change in residual gas pressure, however. References 18: 11 Russian, 7 Western.
[74-6508]

UDC 535.345.67

USE OF WEDGE INTERFERENCE FILTERS AS DISPERSING ELEMENTS FOR SPECTRAL INSTRUMENTS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 34-37 manuscript received 20 Mar 79

STOLOV, YE. G.

[Abstract] A method is suggested allowing significant expansion of the capabilities for use of interference filters by more complete realization of selective properties. The study involves a system, the optical axis of which contains an input slit, a collimator lens, an interference filter with a rectangular spectral characteristic, a moving wedge filter with a highly selective spectral characteristic, a lens to focus the radiation on the surface of a receiver and an electric drive to move the wedge filter back and forth. The light flux striking the intake slit is converted to a small aperture beam which passes through the filters and is then focused on the receiver. At each moment the light flux passes through a narrow section of the surface of the wedge filter which performs reciprocating motion, thus producing a variable signal at the output of the receiver. Conditions are noted to increase the sensitivity and selectivity of the device. Figures 2; references 7: 2 Russian, 5 Western.

[74-6508]

UDC 681.785.536+681.785.537

SECONDARY DISPERSION IN PRISM MONOCHROMATORS IN TYPE SF-26 SPECTROPHOTOMETERS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 46-47 manuscript received 5 Apr 79

IOANNISIANI, A. B.

[Abstract] In monochromators based on autocollimation, secondary incidence of radiation on a dispersing element and subsequent reflection in the direction of the output slit are possible. An effect of this kind was observed by the authors in the SF-26 spectrophotometers prism monochromator, in which the input and output slits are placed one above the other. The spectrum formed by the prism extends far into the UV, where the dispersion of the fused quartz prism is particularly great. The area of existence of secondary dispersion within the working range of wavelengths of the monochromator

was established by the use of a set of linear spectrum sources. Secondary dispersion can be eliminated by screening a portion of the prism, which reduces the effective aperture by 15-20%. The influence of secondary dispersion on the accuracy of spectrophotometric measurements can be reduced by additional radiation filters selected from a graph presented in the article. Figures 2; references 3 Russian.

[74-6508]

UDC 621.365.91

EXPLOSIVELY DRIVEN MAGNETIC FIELD COMPRESSION GENERATOR WITH PLASMA LOAD

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 46-52 manuscript received 20 Nov 78

DIVNOV, I. I., ZOTOV, N. I., KARPOV, O. P., KLOKOV, B. G. and KHRISTOFOROV, B. D., Moscow

[Abstract] Explosively driven magnetic-field generators (EMG) are promising major sources of electrical energy for powering various electrophysical facilities. The criterion for the usefulness of EMG is the ratio between energy transmitted to the load and the powering energy: the higher that ratio is the more workable the EMG is. In this connection, experiments with EMG energy transfer to a resistive-inductive load represented by a heavy-current discharge in air under normal pressure as well as under a pressure of 10^{-2} mm Hg are described. The powering energy of EMG was the same in all experiments: $W_0 = 60 \pm 5$ kJ. In air of normal density the discharge was initiated through the electrical explosion of 0.02 mm thick specimens of aluminum foil of varying size (measuring 20x10, 40x15, 80x15 cm) with the initial resistance correspondingly amounting to 3.0; 4.0; and 8.0×10^{-3} ohm, respectively. It was found that the transmitted energy increased to 240 kJ when the resistance increased from 5 to 50×10^{-3} ohm; at the same time, nearly the entire magnetic energy stored by the instant of maximum constriction in EMG was released in the load. The achieved transmitted energy of 240 kJ was 4 times as high as the powering energy of EMG. Calculations point to the possibility of further increasing the active energy by increasing the load inductance, among other things. Figures 3; references 9 Russian.

[62-1386]

FLUID MECHANICS

UDC 532.551:66.015.24

HEAT TRANSFER DURING TURBULENT FLOW OF LIQUID METAL THROUGH CHANNELS WITH VARIOUS CONDITIONS AT THE WALL

Moscow ATOMNAYA ENERGIYA in Russian Vol 48, No 4, Apr 80 pp 233-238 manuscript received 24 Jan 79

KADER, B. A.

[Abstract] An overview is presented of the problem of heat transfer during turbulent flow of liquid metal through a channel. Various possible conditions in the boundary layer are stipulated in terms of characteristic linear scales. The solution, depending on the mode of heat transfer either by molecular forward flow or by turbulence, is expressed in terms of semiempirical relations between criterial numbers (N_{Nu} , $N_{Pe} = N_{Re} \cdot N_{Pr}$) consistent with the principles of dimensional analysis. For boundary conditions of the first or second kind and of the third kind at the wall, taking into account the thermal resistance and the wall thickness, distributions of the heat transfer coefficient along the thermally initial zone and lengths of its stabilization zone have been calculated and measured by several authors. Here typical results are shown based on theoretical and experimental data for several liquid metals: mercury, eutectic bismuth-lead alloy, bismuth, tin and sodium. Figures 4; references 15: 10 Russian, 5 Western.

[70-2415]

UDC 536.242

EXPERIMENTAL STUDY OF HEAT EXCHANGE WHEN HELIUM FLOWS IN IN CERMET TUBES

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 3, Sep 79 pp 419-423 manuscript received 16 Dec 78

VASIL'YEV, L. L., BOBROVA, G. I. and STASEVICH, L. A., Institute of Heat and Mass Exchange imeni A. V. Lykov, Academy of Sciences BSSR, Minsk

[Abstract] Experiments are done to determine the effect that suction of part of the flow through the porous walls of a sintered bronze pipe has on the heat exchange process when helium is flowing through the pipe at a temperature of 7-9 kelvins. The porosity of the pipe wall varied from 28 to 40% with maximum pore size of 190 μm , and average pore size of 60 μm . The pipes were heated by passing direct current through the walls. It was found that helium suction through the wall of the tube reduces the temperature level lengthwise throughout the investigated range of Reynolds numbers (1.6-4.5) $\cdot 10^4$. A change in porosity from 28 to 40% had no appreciable influence on temperature distribution. A comparison with data in the literature shows that the influence of suction on temperature distribution and the heat exchange coefficient is the same for helium as for air. Figures 3; references 9: 2 Russian, 7 Western.

[64-6610]

UDC 536.25

FREE-CONVECTIVE HEAT EXCHANGE OF A CYLINDER WITH EXPONENTIALLY DECREASING HEAT FLUX ON THE SURFACE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 3, Sep 79 pp 508-512 manuscript received 9 Feb 79

SOKOVISHIN, YU. A. and SHAPIRO, M. V.

[Abstract] The authors consider free motion of a fluid around a vertical cylinder heated in the base. It is assumed that the fluid is incompressible, that the physical properties are constant, and that viscous dissipation is negligible. The heat flux on the wall of the cylinder decreases exponentially with height. Curves are given for the distribution of velocities and temperatures in the boundary layer, temperature behavior of the wall and change in heat transfer from the surface. A thin-layer method with consideration of boundary conditions of the second kind is developed to get explicit

relations for calculating heat transfer. It is shown that the accuracy of calculations can be improved with consideration of the "thick" layer. Figures 4; references 5: 4 Russian, 1 Western.
[64-6610]

UDC 536.244

HEAT TRANSFER STUDY WITH FLOW AROUND CYLINDRICAL BODIES IN A SYSTEM OF CIRCULAR JETS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 5, Nov 79 pp 773-776 manuscript received 26 Mar 79

SYROMYATNIKOV, N. I., VASANOVA, L. K., BADER, V. I. and KORYAKIN, A. V., Urals Polytechnical Institute imeni S. M. Kurov, Sverdlovsk

[Abstract] A study is made of the heat transfer from cylinders of various diameters placed in a system of axisymmetrical jets washing them transversely. The studies were performed on an experimental installation in which air was fed into a static pressure chamber through a perforated grate in the shape of a semicylinder with apertures from 1.0 to 5.5 mm in diameter in a grid. Heat transfer from the cylinders was studied by means of electrocalorimeters with a constant value of heat flux. The influence that parameters such as cylinder size, aperture size and placement have on the coefficient of heat transfer is defined. Figures 4; references 2 Russian.
[67-6508]

UDC 536.242:621.039.534

THE PROBLEM OF MIXING OF HEAT-TRANSFER MEDIUM AMONG CHANNELS IN GROUPS OF FINNED RODS

Minsk INZHENERO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 5, Nov 79 pp 777-783 manuscript received 23 Jan 79

DZYUBENKO, B. V.

[Abstract] Power generating installations of various types currently widely use bundles of cylindrical tubes with spiral fins, designed to intensify the process of mixing of the heat-transfer medium among the spaces in the bundle to make temperature and velocity field more uniform. This article studies the method of analysis of the results of experimental studies performed by various authors in this field, and derives equations for calculation of the mixing factor. The equations produced for calculation of the mixing fact indicate that the numerical value of this coefficient depends greatly on the length of the bundle of tubes. Figures 2; references 10: 8 Russian, 2 Western.

[67-6308]

UDC 533.6

NUMERICAL MODELING OF AN EXPLOSIVE PLASMA GENERATOR IN THE GAS DYNAMIC APPROXIMATION

Minsk INZHENERO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 5, Nov 79 pp 859-867 manuscript received 15 Jan 79

ROMANOV, G. S. and URBAN, V. V., Scientific Research Institute of Plasma Physics at Belorussian State University imeni V. I. Lenin

[Abstract] An attempt is made at direct numerical modeling of the gas dynamic processes which occur in the explosive plasma generator suggested by A. Ye. Voytenko. This generator consists of a closed chamber in the form of a spherical segment filled with the working gas. A metal plate is forced by an explosion in the direction of the vertex of the segment, expelling the working gas into a tube located at the vertex. The gas is highly compressed and greatly accelerated in the direction of the axis of the tube, so that the mass velocity of the gas is close to the phase velocity of movement of the point where the plate meets the segment, and is several times greater than the velocity of the plate. The gas is therefore transformed

to a plasma with parameters $T=10^5$ K, $p=10^{10}$ Pa, $N=10^{17}$ m $^{-3}$, approximately. The processes in the generator are modeled by calculation of the unstable axisymmetrical flow throughout its entire area. The calculations were performed using a program written in FORTRAN on a Minsk-32 computer and a calculation grid with various numbers of cells across the axis. It was found that as the number of cells in the grid was increased, the results of the calculation changed little. Figures 4; references 13: 10 Russian, 3 Western. [67-6508]

UDC 536.58:536.248.2

PROBLEMS OF VERTICAL HIGH-TEMPERATURE HEAT PIPES

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 38, No 3, 1980 pp 389-395 manuscript received 9 Nov 78

IVANOVSKIY, M. N., SOROKIN, V. P., deceased, and CHULKOV, B. A.

[Abstract] The problems which arise during development of high-temperature vertical heat pipes having simple and composite wicks are considered. High-temperature vertical heat pipes are used in atomic power engineering, electronic equipment, chemical technology and other fields of technology. The heat in these pipes must frequently be raised to a significant height, high heat transfer must be provided and thermal stabilization must be ensured when developing them. The capillary structure of the pipes must be wetted with liquid through the entire height of the heating zone to avoid burn-through of the pipe under boundary conditions of the second kind. Heat transfer was studied experimentally on three sodium gas-controlled heat pipes with simple and composite wicks. The experiments were conducted both with and without a noncondensing gas in the vapor space of the pipe and with the presence of helium in it. It was established that the use of a combination wick permits development of gas-controlled heat pipes with comparatively high heat transfer. Figures 4; references 5: 2 Russian, 3 Western. [68-6521]

UDC 536.24

HEAT TRANSFER IN PERMEABLE WALL TUBES WITH INTERNAL HEAT SOURCES

Minsk INZHENERO-FIZICHESKIY ZHURNAL in Russian Vol 38, No 3, 1980 pp 396-402
manuscript received 11 Apr 79

YEROSHENKO, V. M., ZAYCHIK, L. I. and RAMOVSKIY, V. B., Power Engineering
Institute imeni G. M. Krzhizhanovskiy, Moscow

[Abstract] Heat transfer in tubes with uniform injection or suction in the presence of heat sources is considered. Energy equations in the presence of internal uniformly distributed heat sources through the pipe in the case of boundary conditions of the first and second kind are found. It is assumed that the flow is hydrodynamically stabilized and the effective thermal conductivity coefficient does not vary through the length of the pipe, the axial thermal conductivity is negligible and the physical properties of the liquid are constant. Figures 4; references 8: 3 Russian, 3 Western.
[68-6521]

UDC 536.242

EFFECT THAT STEP VARIATION IN COOLANT TEMPERATURE HAS ON A FUEL ROD WITH CLADDING

Minsk INZHENERO-FIZICHESKIY ZHURNAL in Russian Vol 38, No 3, 1980 pp 514-521
manuscript received 9 Nov 77

LORENZINI, E. and SPIGA, M., Italy

[Abstract] The problem of a sudden temperature increase of coolant in a nuclear reactor operating in the steady state is considered. This increase can occur due to leakage of coolant in the core or as a result of an accident or for other reasons. It is assumed that the rate of heat release (during fission) remains constant and that the fuel and cladding temperature increases until a new steady state is reached. An analytical expression is found for temperature distribution as a function of time in cylindrical fuel elements with cladding. The given problem reduces to an emergency situation which may occur in a nuclear reactor, and solution would permit selection of the appropriate materials and determination of the operating conditions of the installation. The transient state is caused by step variation in the coolant temperature. Some numerical results are presented and discussed. Figures 4; references 6 Western.
[68-6521]

UDC 532.526

A NONEQUILIBRIUM VISCOUS SHOCK LAYER ON BLUNTED CONES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKI ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 15-20 manuscript received 10 Jul 78

VORONKIN, V. G., Moscow

[Abstract] A study is made of the nonequilibrium flow of dissociated and ionized air in a shock layer, considering the dissipative processes of viscosity, heat conductivity and diffusion. The oscillating reaction of the molecules of oxygen and nitrogen is considered. The fraction of charged particles is considered negligible. Measurements of the profile of electron concentration in the shock layer were performed on a RAM-C apparatus with a series of Langmuir probes on a pylon. The method of calculation of the parameters of the nonequilibrium viscous shock layer on blunted cones agrees satisfactorily with experimental data found in the literature. The method is also suitable for determination of heat fluxes and the coefficient of friction. Figures 5; references 14: 8 Russian, 6 Western.
[66-6508]

UDC 533.6.011.72

UNSTEADY INTERACTION OF A SHOCK WAVE WITH A BLUNTED BODY IN A SUPERSONIC STREAM

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKI ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 70-76 manuscript received 28 Sep 78

LYAKHOV, V. N., Moscow

[Abstract] Results are presented from the calculation of a two dimensional flow around a blunted body producing a shock wave. It is demonstrated that one dimensional models are unsatisfactory in the accuracy of their description of the flow in this situation. However, the finite-difference method is sufficiently effective for modeling of loads on the surfaces of a body in this situation. Figures 4; references 22: 16 Russian, 6 Western.
[66-6508]

UDC 533.6.011.8

FLOW OF A HYPERSONIC STREAM OF RAREFIED GAS AROUND A SPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 85-90 manuscript received 6 Jul 78

ARTOMONOV, A. K. and ARKHIPOV, V. N., Moscow

[Abstract] The problem of the structure of the shock layer near the critical stream line on a sphere in a hypersonic flow of a rarefied gas is studied. It is assumed that the flow near the critical line is self-similar. The initial problem is solved using a program based on the Runge-Kuta method for solution of the Cauchy problem and the method of Newton for solution of a system of algebraic equations. Figures 4; references 8: 5 Russian, 3 Western. [66-6508]

UDC 532.516

RESISTANCE OF POROUS CYLINDERS IN A STREAM OF VISCOS FLUID AT LOW REYNOLDS NUMBERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 122-124 manuscript received 8 Aug 78

STECHKINA, I. B., Moscow

[Abstract] A solution is presented of the problem of transverse flow of a viscous fluid around a continuous cylinder in a porous envelope, in particular a porous cylinder, where the flow is constricted (in a system of cylinders), as well as an isolated cylinder with arbitrary values of permeability. More particularly, the steady flow of a viscous incompressible fluid around a system of cylinders with porous envelopes located perpendicular to the flow at low Reynolds numbers is studied. A multicell hydrodynamic model is used to describe the system and the planar movement of the liquid flowing around the cylinder is studied only in an area limited by the radius $a^2 \pi a^{-1/2}$, where a is the radius of the cylinder, a is the fraction of the volume occupied by the solid cylinders. Figures 2; references 7: 2 Russian, 5 Western. [66-6508]

UDC 532.528

SYMMETRICAL FLOW WITH CAVITATION AROUND A WEDGE WITH A SOURCE OF FLUID ON THE WEDGE OR IN THE FLOW

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 6, Nov/Dec 79 pp 137-141 manuscript received 14 Jun 77

SOTINA, N. B. and POMINYKH, V. V., Moscow

[Abstract] A solution is presented to the problem of symmetrical flow with cavitation around a wedge in a planar stream of an ideal incompressible fluid with a point source in the flow or on the wedge. Expressions are produced for the forces acting on the source and the wedge. Conditions are indicated under which negative resistance (thrust) arises, and the forms of the free stream lines are constructed for various values of flow parameters. The summary force acting on the wedge and the source is determined by the asymptotic form of the free stream lines. Figures 6; references 4 Russian.
[66-6508]

UDC 533.6

EXPERIMENTAL STUDY OF THE INITIAL STAGE OF OPERATION OF A WEDGE-SHAPED NOZZLE IN A LARGE DIAMETER SHOCK TUBE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 6, Nov/Dec 79 pp 152-156 manuscript received 17 Jan 78

BRITAN, A. B., ZHILIN, YU. V. and MAZMANYANTS, A. P., Moscow

[Abstract] Results are presented from a study of the initial moments of operation of a wedge-shaped shock tube nozzle. It is shown that in the initial moments of operation with overexpansion the primary losses of working time are related to the secondary shock wave and involve only about one half of the entire start up time. The applicability of the results to the study of the initial moments of operation of wedge-shaped nozzles of various geometries is discussed. The experimental work involved start up of the nozzle of a large diameter shock tube with no diaphragm at the inlet. Care was taken to see that during the experimental time a steady flow mode was reached in the section of the nozzle in which measurements were made. The duration of the start up phase is greatly influenced by boundary-layer interactions at the walls, and differs by 10-20 μ s as measured by film sensors and by scanning photographic apparatus. Figures 5; references 7: 5 Russian, 2 Western.
[66-6508]

UDC 533.6.011.55

ESTIMATES OF NONEQUILIBRIUM RADIATION HEATING UPON HYPERSONIC FLOW OF CARBON DIOXIDE AROUND BLUNTED BODIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 158-160 manuscript received 28 Sep 78

GOLOVACHEV, YU. P., Leningrad

[Abstract] A solution obtained earlier for hypersonic nonequilibrium flow around cones with spherical tips is used to estimate the radiation heating of the surface of a body. According to theoretical and experimental data, the radiation of the shock layer in the velocity and density range in question is determined primarily by the fourth positive system of bands of carbon dioxide. In order to get an upper limit estimate for radiation heating, the cross section of deactivation upon collisions with molecules and atoms is assumed equal to the gas kinetic value. The rate of formation of excited molecules as a result of radiation processes is found by solving the equation for radiation transfer. It is found that under the conditions in question, the assumption of local thermodynamic equilibrium cannot be accepted for purposes of estimation of the radiation heating of the surface of the body. Figures 2; references 7: 6 Russian, 1 Western.
[66-6508]

UDC 533.6.001.8

INFLUENCE OF ACCOMMODATION COEFFICIENTS ON AERODYNAMIC CHARACTERISTICS OF A PLATE IN A FLOW OF RAREFIED GAS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 160-163 manuscript received 6 Jul 78

GORELOV, S. L. and YEROFEYEV, A. I., Moscow

[Abstract] The boundary conditions on a plate are determined for the case of flow of a monatomic gas around the plate at zero angle of attack using the scheme of diffuse-specular reflection of molecules. Two versions of this scheme are studied, in one of which some of the molecules are specularly reflected, while some are diffusely reflected at a temperature equal to the surface temperature. In the other scheme it is assumed that the distribution function of reflected molecules is maxwellian, while the temperature is determined by the energy accommodation coefficient. The problem is solved by

the method of direct modeling in which the movement of a set of molecules modeling the actual gas is traced. A rectangular area is studied near the body, and is broken up into cells, the dimensions of which are smaller than the mean free path of a molecule. The processes of movement of molecules and collisions between them are analyzed in sequence. Figures 3; references 4: 3 Russian, 1 Western.
[66-6508]

UDC 534.222.2

A PARTICULAR CASE OF DENSITY DISTRIBUTION BEHIND AN UNSTABLE SHOCK WAVE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 6, Nov/Dec 79 pp 163-167 manuscript received 25 Jul 78

PISKAREVA, M. V. and SHUGAYEV, F. V., Moscow

[Abstract] A study is made of the distribution of density behind an unsteady shock wave at a predetermined Mach number, utilizing the fact that where $M=M_*(\gamma)$ there is a relationship between the first and second derivatives of density with respect to a perpendicular behind the shock wave. The form of the density profile is studied in dimensionless variables behind plane, cylindrical and spherical shock waves in the vicinity of the leading edge of the wave. Figures 5; references 4: 3 Russian, 1 Western.
[66-7608]

UDC 66.096.5:532.529.5

INVESTIGATION OF HYDRODYNAMICS AND HEAT TRANSFER IN BACK-PULSATING FLUIDIZED BEDS

Minsk IZVESTIYA VUZOV: ENERGETIKA in Russian No 2, 1980 pp 55-60 manuscript received 23 Dec 78

ZHARKOV, A. A., FILIPPOVSKIY, N. F. and BASKAKOV, A. P., Ural Polytechnical Institute imeni S. M. Kirov

[Abstract] A disadvantage of fluidized beds is the ejections of finegrained materials from their surfaces, with attendant loss of those materials. This can be averted by preventing the emergence of bubbles to the surface. The hydrodynamics of such (back-pulsating) beds is a function of the pulsation frequency n (number of openings and hence also of closings of the valve providing gas at the bed bottom), the porosity of the bed, and the mean fluidization rate (air discharge rate per unit area of grate). These factors were investigated on an experimental set-up in which a pulsating flow of gas was supplied to the bed bottom at the frequency of 0.25-3 Hz during the fluidization of corundum powder with particle sizes of 60-120, and 400 μm . The bed depth in all cases was 240 mm. Calorimetric, thermocouple, and motion-picture observations showed that loss of bed material to the ambient air can be prevented if the fluidized bed is equipped with two gas valves instead of one--with the second valve intermittently forcing a flow of gas from the top down instead of from the bottom up through the bed. Such controlled back-pulsation or alternate compression and expansion of the bed can under specified conditions not only preclude loss of bed material into the ambient air but also improve the quality of fluidization and enhance heat transfer.

Figures 3; references 6: 4 Russian, 2 Western.
[75-1386]

UDC 533.697.4:532.529

FILM FORMATION DURING TWO-PHASE FLOW ACROSS A SURFACE

Minsk IZVESTIYA VUZov: ENERGETIKA in Russian No 2, 1980 pp 60-63 manuscript received 17 Jul 78

DASKAL, YU. I., Moscow Energetics Institute

[Abstract] The formation of a film owing to the interaction of the discrete phase of a two-phase flow with a surface and the attendant flows of secondary and reflected particles represent major problems of the theory of two-phase media. This concerns in particular the pattern of formation of a film of moisture in flow parts of turbomachinery, which is closely related to erosive wear, turbine cascade design, and the like. In this connection the interaction between droplets and a surface is investigated by methods of the kinetic theory. Corresponding kinetic equations for the discrete phase in two-component flows are derived and, on this basis, a differential equation of film growth is formulated. By way of an example, the processes of droplet deposition and film formation in a turbine nozzle cascade operating on wet steam are investigated. A closed system of equations describing the droplet distribution function in the flow core is thus presented. The numerical calculations are found to be in agreement with the theory. Figures 1; references 6 Russian.

[75-1386]

UDC 533.6.013

INERTIA CHARACTERISTICS AND HYDRODYNAMIC DAMPING OF VIBRATIONS OF CIRCULAR CYLINDERS IN A FLUID MEDIUM

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 115-121 manuscript received 18 Oct 77

SINYAVSKIY, V. F., FEDOTOVSKIY, V. S. and KUKHTIN, A. B., Physico-Technical Research Institute, Obninsk

[Abstract] Inertia and damping characteristics of an elastic circular cylinder in a fluid medium near a plane wall are analyzed by the method of electrodynamic analogy and simulation on electrical conducting paper. The apparent mass and then the damping coefficient, both referred to their respective values in an infinite volume of an ideal fluid, are calculated as functions of the distance-to-radius ratio. The method is extended to a bundle of

cylindrical rods, such as fuel elements in a nuclear reactor, or tubes in a heat exchanger forming a triangular or square array and vibrating in planes parallel to any one side or to any angle bisector (diagonal in the case of a square array). On the basis of a graphical evaluation, both the Stokes relation for the apparent mass in the case of two coaxial shells and the energy relation for the damping coefficient in the boundary layer are modified to fit this particular situation with a smaller than 0.2 distance-to-radius ratio. Figures 4; references 5 Russian.

[65-2415]

UDC 629.12.073.243.4:532.59(045)

EXCITATION FORCES ACTING ON A SHIP DURING LONGITUDINAL ROCKING IN SHALLOW WATER AND IN DEEP WATER

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 136-139 manuscript received 21 Mar 79

VOROB'YEV, YU. L., Odessa Institute of Maritime Fleet Engineers

[Abstract] A ship is considered which floats on low water and on which impinge plane forward moving waves of small amplitude. The vertical excitation force and the excitation moment acting on this ship are calculated by asymptotic expansion of the velocity potential rather than by solution of the diffraction problem. The universal expression for both is put in a form explicitly indicating their sine and cosine components. It is further extended to apply also to deep water, regarded here as a limiting case, by letting the depth approach infinity. Numerical calculations have been made for three series 60 hulls with 0.6, 0.7, and 0.8 fill factors, the results indicating how the amplitude of the excitation force depends on the water depth and on the course angle under conditions of lateral or frontal wave impingement. Figures 4; references 6: 4 Russian, 2 Western.

[65-2415]

PROBLEMS OF MOISTURE SEPARATION IN TURBINE SYSTEMS IN ATOMIC ELECTRIC POWER PLANTS

Moscow TEPLOENERGETIKA in Russian No 2, Feb 80 pp 41-46

POVAROV, O. A., candidate of technical sciences, Moscow Power Engineering Institute

[Abstract] The performance of turbine systems operating from the saturation line, namely their reliability and economy, depends largely on the effectiveness of moisture removal from the wet steam along its entire flow channel, which includes the high-pressure stage and the low-pressure stage as well as exhaust and bypass tubes. A minimum moisture content, below 0.2%, is desirable at the inlet to the high-pressure stage. In atomic electric power plants the problem is compounded by inadequate inspection owing to a lack of appropriate instruments. Several methods of moisture separation and removal have already been introduced and continue to be studied for further improvement. First comes removal through clearances between nozzle blades, with a varying effectiveness which depends on a number of blade design and steam flow parameters. Next comes removal behind the nozzle, through the clearance between nozzle and runner. Moisture is also separated in the runner, here its fine dispersion and high values of the Reynolds number characterizing the flow render the process rather inefficient. Another method is installation of special separator stages, of which three basic types can be considered: 1) with a moderately high separation capability and an economy comparable to that of conventional turbine stages, 2) with a very high separation capability but an efficiency lower than that of conventional turbine stages, 3) with the wheel mounted on separate bearings for most effective operation under low temperature and velocity heads. In addition there are available external separators-superheaters, perhaps the most promising devices, but their development and design have not yet been completed for operation under inherent conditions of film flow. The louvered ring type is of particular interest, because of its compactness and relatively low cost. Figures 8; references 17: 16 Russian, 1 Western.

[72-2415]

ANALYTICAL REPRESENTATION OF THE EFFECTIVE TEMPERATURE FOR CALCULATION OF RADIATIVE HEAT EXCHANGE

Moscow TEPLOENERGETIKA in Russian No 2, Feb 80 pp 52-57

BLOKH, A. G., doctor of technical sciences, Scientific-Industrial Association of the Central Boiler and Turbine Institute, ADZERIKHO, K. S., candidate in physico-mathematical sciences, Institute of Physics, Academy of Sciences of the Belorussian SSR, TROFIMOV, V. P., engineer, Institute of Heat and Mass Transfer, Academy of Sciences of the Belorussian SSR, and LOZHECHNIK, F. D., engineer, Institute of Mathematics, Academy of Sciences of the Belorussian SSR

[Abstract] A method of defining the effective temperature is proposed consistent with an analysis of radiative heat exchange. The reference emitter is an isothermal plane-parallel layer with radiating and reflecting but not scattering boundary surfaces, i.e., with a definite thickness and optical characteristics (reflection coefficient, emissivity) at a given wavelength. The differential equation of heat radiation is solved for the intensity of radiation from such a layer. The solution to this equation is then extended to radiation from a nonisothermal gray body and the integral in it is evaluated on the basis of several possible temperature distributions, including a constant-temperature interval. Computer-aided high-precision calculations according to a program written in FORTRAN-6, with the constant-temperature interval varied over a wide range within the optical thickness of the layer, reveal that neither the arithmetic mean nor the geometric mean accurately represent the effective temperature. Instead,

$$\theta_{\text{eff}} = \theta_c [1 + (\theta_o/\theta_c) e^{-0.19 \tau_0}]$$

is proposed for the effective referred temperature. Here $\theta = \lambda T$, T is the temperature, λ is the wavelength, τ_0 is the optical thickness of the layer, the subscript 'o' refers to the temperature (maximum) at the center of the layer and the subscript 'c' refers to the temperature within the constant-temperature interval. Figures 5; tables 2; references 16: 8 Russian, 8 Western.

[72-2415]

INTENSIFICATION OF CONVECTIVE HEAT TRANSFER

Moscow TEPOENERGETIKA in Russian No 2, Feb 80 pp 57-60

PEL'CHUK, V. L., candidate of physico-mathematical sciences, NIKITIN, YU. M., candidate of technical sciences, PUPKOV, YE. I., candidate of technical sciences, SMIRNOV, V. P., candidate of technical sciences, SHUYSKAYA, K. F., candidate of technical sciences, BRAGINA, O. N., engineer, OGIN, YE. D., engineer, POKROVSKIY, YU. YU., engineer, SOROKIN, A. G., engineer, and YAKOVLEVA, N. N., engineer

[Abstract] Intensification of heat transfer within the core of a gas-cooled nuclear reactor is very important, especially from the fuel element cladding. Most effective in this respect is electrochemical surface treatment of the cladding to produce a regular microroughness, which induces eddies. Experience has shown that best results in the case of cladding made of EI847 alloy steel are obtained by treatment with 30-35% NaClO_4 or NaNO_3 at 18-20 V. In an experimental study made at the All-Union Institute of Heat Engineering such cladding was simulated by inserts with discrete artificial microroughness on one surface inside a channel 1365 mm long (length-to-diameter ratio 130) and thus exposed to an annular stream of air. The test data have been evaluated on the basis of the best fitting empirical relation according to D. Wilki, consistent with the principles of dimensional analysis. Graphs of the dimensionless convective heat transfer coefficient and hydraulic drag coefficient as functions of the Reynolds number and of the roughness height for various width-to-height and pitch-to-height ratios) indicate that a microroughness with $h = 0.1$ mm is most effective, especially when relative width is 0.8, but also that the advantage over a smooth surface diminishes when rough spots become wider and when the Reynolds number increases. The latter was varied from $25 \cdot 10^3$ to $650 \cdot 10^3$, with the Mach number not exceeding 0.5, and the temperature head was varied from 60 to 100 K with a 10 K rise of the ambient temperature. Figures 4; tables 1; references 8: 4 Russian, 4 Western.

[72-2415]

UDC 537.523.001.5

ELECTRIC ARC FIELD STRENGTH IN DEVELOPED TURBULENT FLOW OF AIR

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 11-16 manuscript received 28 Nov 78

ZHUKOV, M. F., ZASYPKIN, I. M., MISHNE, I. I. and Sazonov, M. I., Novosibirsk

[Abstract] The electric field strength of an arc burning in a developed turbulent flow is investigated as a function of current intensity, channel diameter, and gas pressure and flow rate. The experiments were performed in a plasmotron with an interelectrode insert in the presence of arc current intensities of from 40 to 600 amp, with thyristor and mercury rectifiers serving as the power supply sources. Flow turbulence in the channel was induced by means of periodic gas blasts. Measurements of electric field strength along the channel, as performed with the aid of an 8-50 electrostatic voltmeter, showed that the field strength increases with decrease in channel diameter and increase in the flow rate and pressure of gas. Furthermore, electric field strength decreases with increase in current intensity. The derived general formula for electric field strength is found to be in agreement with the experimental findings, which is of value considering that plasmotrons with interelectrode inserts are highly promising means of the conversion of electrical to thermal energy and development of high-power arcs. Figures 4; references 10: 8 Russian, 2 Western.

[63-1386]

UDC 533.9.082.76

SATURATION CURRENTS AND PROBES IN HIGH-DENSITY PLASMA

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 16-24 manuscript received 25 Oct 78

BENILOV, M. S. and TIRSKIY, G. A., Moscow

[Abstract] The current-voltage characteristics of discrete electrical probes in dense plasma fluxes in the presence of high positive and negative surface potentials are analyzed in theory for a three-component (ion-electron-neutral) ionized gas enveloping a conducting charged body (the electrical probe). The effect of saturation currents is investigated with allowance for the variability of properties of the gas, gas-phase ionization, and the mutual recombination and collisions of charged particles. Assuming the probe surface

to be ideally absorbing, ideally catalytic, and non-emissive, a system of corresponding boundary conditions for ion and electron concentrations is derived. It is shown that saturation currents exist in the presence of a fixed ion-neutral and electron-neutral ratio of drag coefficients in the flow and low Debye layer thickness. The obtained general formulas for saturation current densities serve to derive asymptotically rigorous diagnostic formulas for a broad class of particular instances of flow of gases in thermal equilibrium. Figure 1; references 16: 13 Russian, 3 Western.

[62-1386]

UDC 621.373.826.038.823

NUMERICAL INVESTIGATION OF THE EFFECT OF FRICTION LOSS IN THE NOZZLES OF GASDYNAMIC $\text{CO}_2\text{-N}_2\text{-He}$ LASERS

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 61-65 manuscript received 1 Dec 78

KOZLOV, V. F., Zhukovskiy

[Abstract] Sets of short nozzles with critical cross sections are used in certain gasdynamic lasers to assure a markedly nonequilibrium flow of gas. Until recently it had been assumed that friction loss in such nozzles is uniformly affected by interactions of various types of gas-molecule vibrations with the nozzle surface. Now, however, a new model of these interactions is investigated, considering that polyatomic molecules generally have a complex spatial structure and this should result in different relaxation rates of their vibrational degrees of freedom at the phase interface. Friction loss in the nozzle of three-component ($\text{CO}_2\text{-N}_2\text{-He}$) gasdynamic lasers is investigated in the presence of a stagnation pressure of $1.013 \cdot 10^6$ Pa and a stagnation temperature of 1900 K in the antechamber. Corresponding boundary-layer equations are composed in a (x, y) -coordinate system related to the nozzle surface, and inviscid flow equations, in an (X, Y) -coordinate system whose origin lies at the center of the minimal nozzle cross section. Numerical integration of these equations, as based on the finite-difference method, shows that in the investigated models of heterogeneous relaxation at nozzle surface, friction results in insignificant heating of the antisymmetrical mode in CO_2 and of vibrations in N_2 . It is found that the losses in gain and boundary-layer thickness reach their maximum for nozzles with heat-insulated walls, whereas in cooled-wall nozzles these losses markedly diminish, owing to the differing effect of the processes of vibrational relaxation at nozzle surface. Figures 5; references 13: 11 Russian, 2 Western.

[62-1386]

UDC 532.525.2

A NUMERICAL STUDY OF UNSTABLE INTERACTION OF A SUPERSONIC JET WITH A FLAT OBSTACLE

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 93-99 manuscript received 2 Nov 78

KUZ'MINA, V. YE. and MATVEYEV, S. K., Leningrad

[Abstract] Unstable interaction of an axisymmetric supersonic ideal gas jet with a flat barrier is investigated by simulating the gas nozzle by an open-ended tube and calculating the attendant interaction processes on a uniform rectangular grid with the aid of the Godunov difference scheme from the standpoint of the inviscid non-heat-conducting gas model. Analysis of the findings shows that, for the interaction modes considered, a subsonic flow region exists in the peripheral gas flow in the neighborhood of the barrier. In addition, a peripheral pressure maximum exists at the barrier, and a "reciprocal" flow of gas from the periphery toward the center as well as from the barrier toward the nozzle appears at certain instants in the central region (the region bounded by the central shock wave, the axis of symmetry, the barrier surface, and the surface of tangential discontinuity). These calculations are found to be in agreement with experiment. Figures 6; references 20: 19 Russian, 1 Western.

[62-1386]

UDC 532.517.4

MODELING TURBULENT MOMENTUM TRANSPORT IN THE WAKE OF A CYLINDER BY THIRD-MOMENT EQUATIONS

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 99-107 manuscript received 13 Dec 78

KURBATSkiY, A. F. and ONUFRIYEV, A. T., Novosibirsk and Dolgoprudnyy

[Abstract] Two possible methods for closure of the system of equations of moments of the velocity field of an inhomogeneous developed turbulent field are compared for turbulent transport of nongradient nature. The methods compared are the Millionshchikov hypothesis of quasinormality and the 13-moment method of the kinetic theory of gases. An elementary example selected is that of the flow in the wake of a circular cylinder. Findings on the distributions of mean velocity, turbulent flows (second moments of turbulent fluctuations), and third moments of turbulent fluctuations of the velocity

field (processes of turbulent diffusion) in the cylinder's wake in the presence of high Reynolds numbers are presented. The numerical findings are compared with Townsend's experimental data. Figures 6; references 19: 10 Russian, 9 Western.
[62-1386]

UDC 539.198:533.6.0018

FORMATION OF SUPERSONIC MOLECULAR BEAMS WITH THE AID OF A SKIMMER

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 107-115 manuscript received 14 Nov 78

ZARYN, A. YE. and SHARAFUNDINOV, R. G., Novosibirsk

[Abstract] The effect of the interaction between the skimmer and the incident gas flow on the molecular velocity distribution function and its normalized moments (flow velocity and translational temperature) was experimentally investigated. It was found that the greater that effect (i.e. the lower the Knudsen number, here characterizing the degree of scattering of the molecular beam in the skimmer inlet area) the larger the skimmer diameter is. As based on an investigation of the process of the formation of molecular beams from supersonic jets by the time-of-flight and electron-beam methods, a correction curve is plotted that accounts for the effect of skimmer interaction on the gasdynamic flow parameters, and it is established that increasing the stagnation pressure to ≥ 500 mm Hg produces conditions in which the "true" temperature equals the theoretical isentropic temperature. These findings require revising the skimmer geometry so as to use short skimmers with sufficiently large interior and exterior angles to prevent "plugging" of the skimmer and thus blockage of the molecular beam. Figures 5; references 15: 6 Russian, 9 Western.
[62-1386]

UDC 533.932-533.601.18:539.198

A STUDY OF THE ENERGY ACCOMMODATION COEFFICIENTS OF POSITIVE IONS OF RAREFIED PLASMA FLUX ON THE SURFACES OF CERTAIN MATERIALS⁶

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 115-118 manuscript received 5 Jun 78

GUBIN, V. V., REZNICHENKO, N. P. and SHUVALOV, V. A., Dnepropetrovsk

[Abstract] The energy accommodation coefficients of a stream of particles on the surface of a body is a major aspect of the interaction between a body and a gas flow. In this connection, a formula for the accommodation coefficient α_i of ions on the act./s surface of heat-loss anemometer probes is presented. The related experimental research was performed in a gasdynamic plasma facility, in a flux of partially ionized low-density gas generated by a plasma accelerator, with electron-shock ionization of the working medium. The plasma flux velocities ranged from 6.5 to 25 km/sec. The α_i of N_2^+ , Ar^+ , Kr^+ , and Xe^+ of rarefied plasma flux flowing at velocities of 6.5-25 km/sec were measured on the surfaces of disk-shaped 0.12 mm thick heat-loss anemometer probes made of such structural materials as molybdenum, niobium, aluminum, AMg6-M and D16T aluminum alloys, 2 Kh13, 12Kh18N10T, and St.25 steels, and the silicon element of solar panels. The findings indicate that α_i are a function of the energy and molecular weight of the flux ions. Figures 3; references 11: 9 Russian, 2 Western.
[62-1386]

UDC 532.529

TWO-WAVE MODEL OF THE PROPAGATION OF PERTURBATIONS IN FLUIDS CONTAINING GAS BUBBLES

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIK I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 119-127 manuscript received 2 Nov 78

GASENKO, V. G., NAKORYAKOV, V. YE. and SHREYBER, I. R., Novosibirsk

[Abstract] A model for the propagation of perturbations corresponding to both branches of the dispersion curve for the propagation of sound in fluids containing gas bubbles is presented. The pertinent formula, applying to waves of finite amplitude and of any slope of increment, is derived from equations of the hydrodynamics of a homogeneous bubble-containing suspension with allowance for compressibility of the fluid. The derived formula, which corresponds to both branches of the dispersion curve and contains two

characteristic speeds of sound, is conditionally termed the two-wave non-linear equation. Numerical integration of the presented formulas is carried out and the evolution of perturbations in a bubble-containing fluid is described on the basis of the two-wave model, which is found to be more plausible than the Klein-Gordon approximation. Figures 5; references 13: 12 Russian, 1 Western.
[62-1386]

MECHANICS OF SOLIDS

UDC 536.244

THERMAL INTERACTION BETWEEN A GAS LINE AND FROZEN GROUND

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 37, No 3, Sep 79 pp 489-496 manuscript received 16 Oct 78

KRIVOSHEIN, B. L. and YUNUSOV, M., Mathematics Institute with Computing Center, Academy of Sciences TadzhSSR, Dushanbe

[Abstract] In previous research on the thermal conditions of pipes laid in frozen ground, major emphasis has been placed on the heat distribution in the ground, the temperature of the fluid being pumped through the pipe being taken as constant. In this paper the authors consider the two-dimensional problem of change in gas temperature with respect to the length of a pipeline, and in time with consideration of the dynamics of heat exchange with the ambient medium and phase transitions in the soil. This problem includes two groups of equations: one group reflects the conservation laws for gas moving in the pipeline, and the other group describes the distribution of the temperature field of the ground around the pipeline. The numerical solution includes the operation of smoothing of the coefficients in the Stefan condition, and approximation of the smoothed boundary value problem by the ADI method. The resultant system of equations is solved by a sweep method with iteration. This method is applied to calculation of gas transport with cooling in air coolers. The problem is formulated and results are given for optimization of the thickness of insulation, based on preserving the ecological environment in the zone of influence of the gas line. Figures 4; references 14 Russian.
[64-6610]

UDC 539.374

TWO-DIMENSIONAL PROBLEMS IN STATICS OF ELASTOPLASTIC FLEXIBLE SHELLS WITH HOLES UNDER ONE-TIME OR CYCLIC LOADS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 42-48 manuscript received 31 May 79

CHERNYSHENKO, I. S., Institute of Mechanics, Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] The stress distribution in a deep cylindrical shell under an asymmetric one-time or cyclic load is calculated according to the theory of thin shells with two nonlinearities, geometrical and physical, as well as their interaction taken into account. The corresponding nonlinear system of differential equations with variable coefficients for the n-th cycle is reduced to a system of algebraic equations according to the method of finite differences. The boundary conditions with respect to displacements are then modified to account for the presence of a circular hole in the shell. The problem has been solved numerically by iterations on a BESM-6 high-speed computer for such a shell under internal pressure with a circular rigid inclusion (reinforced hole) in the wall. The maximum radial and circumferential stresses calculated with consideration of the nonlinearities are found to be lower than in the elastic approximation. Figures 2; references 12 Russian.
[65-2415]

UDC 674.075:624.074.4

NONLINEAR PARAMETRIC VIBRATIONS OF VISCOELASTIC ORTHOTROPIC CYLINDRICAL SHELLS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 49-55 manuscript received 12 Dec 77

BOGDANOVICH, A. YE. and FELDMANE, E. G., Institute of Polymer Mechanics, Academy of Sciences of the Latvian SSR, Riga

[Abstract] A closed circular shallow cylindrical shell made of a viscoelastic orthotropic material is loaded by an axial force with a constant component and a harmonically alternating one. Its parametric vibrations are analyzed on the basis of the classical theory where transverse shearing strains affect only the location and the width of dynamic instability regions but

not the solution to the nonlinear problem. Hooke's law is extended in integral form to tangential stresses and inertia in the tangential direction is disregarded. The resulting parametric integrodifferential equation is solved by the Runge-Kutta method and the solution, in terms of vibration modes yielding a given deflection, is found to depend on the point on the dynamic instability diagram to which the amplitude and the frequency of the external force correspond. Figures 4; references 12: 10 Russian, 2 Western.
[65-2415]

UDC 539.2

DESIGN OF CYLINDRICAL SHELLS FOR STABILITY UNDER NONAXISYMMETRIC PRESSURE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 56-62 manuscript received 5 Jan 79

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[Abstract] A thin isotropic cylindrical shell is considered under pressure with periodic but nonaxisymmetrically nonuniform distribution over the circumference. In the solution to the fourth-order differential equation of equilibrium the coefficients associated with forces at the median surface and the coefficients associated with deflections prior to loss of stability are of the same order of magnitude. The problem is solved accordingly by the Bubnov-Galerkin method, with the resolvent force and deflection function expressed in the form of a double trigonometric series, for deflections assumed to be symmetric around the circumference with respect to a reference point on it. The effect of subcritical deflection on the magnitude of the critical load is evaluated on this basis, and it is found possible for the latter to be lower in the case of nonuniform pressure than in the case of uniform pressure. Figures 2; references 8 Russian.
[65-2415]

ANALYSIS OF PLATES AND SHELLS WITH COMPLEX CONTOURS

Kiev PRIMLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 63-70 manuscript received 16 Nov 77

PAYMUSHIN, V. N., Kazan' Aviation Institute

[Abstract] A shell with a complex contour is an open one whose median surface σ , parametrized in terms of Gaussian coordinates α^1, α^2 , has contour lines which do not coincide with the coordinate lines $\alpha^1 = \text{const}$. Determining the state of stress and strain in such a case is a nonclassical problem, but here it is shown how this problem can be reduced to a classical one by construction of a region on the median surface parametrized so that the new set of coordinate lines on its boundary will coincide with the contour lines. Mapping of such a region onto the corresponding canonical region is demonstrated in the case of a plane surface and in the case of a closed cylindrical surface with a skew section. The equations of equilibrium in terms of the stress tensor and the strain tensor are derived on the basis of the displacement vector and from the Lagrange variational principle, in accordance with a Timoshenko-type theory based on the straight-line hypothesis and negligible transverse compression. The stability condition yields subsequently a system of five differential equations. A solution requires numerical methods, with whatever boundary conditions stipulated assuming the contour of the median surface to consist of four smooth segments which cut out of it a singly-connected region. Figures 3; references 12 Russian.
[65-2415]

UDC 539.2

FORCE INTERACTION BETWEEN AN ELASTIC HALF-PLANE AND A COATING WITH A LOW FLEXURAL STIFFNESS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 78-83 manuscript received 18 Jan 78

PAVLOV, P. K., Higher Institute of Machine Design and Farm Mechanization and Electrification, Ruse (BULGARIA)

[Abstract] A finite part of the plane surface of a thin isotropic and elastic plate at room temperature is being covered with a hot continuous metallizing layer. The force interaction between the two is analyzed by a method based on functions of a complex variable. Thermal strains due to the temperature difference and resulting stresses subject to Hooke's law are calculated for the appropriate boundary conditions. The problem reduces to the well known Prandtl equation and is solved here with the aid of a trigonometric Lagrange interpolation polynomial which yields approximate expressions for shearing and normal stresses in the coating. Numerical results have been obtained for a steel plate and a steel coating, with all stresses multiplied by a correcting temperature factor which characterizes the real process conditions. The author thanks M. M. TODOROV for the discussion of the results. Figures 1; tables 2; references 4 Russian.

[63-2415]

UDC 534.2:532

FORCED VIBRATIONS OF A SPHERICAL SHELL IN AN ACOUSTIC HALF-SPACE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 16, No 4, Apr 80 pp 122-125 manuscript received 26 Jul 79

RYABUKHA, YU. N., Kiev

[Abstract] A thin elastic spherical shell in an acoustic half-space bounded by a wall is made to vibrate axisymmetrically by a spherical radiator located concentrically inside. The problem is reduced to Helmholtz equations for the medium inside the shell and the medium outside the shell. These equations are solved for the angular distributions of shell deflection and acoustic pressure around the shell surface, involving an evaluation of Legendre polynomials as well as spherical Bessel, Neumann, and Hankel functions. Numerical results for a glass-plastic shell with water inside and outside indicate

that the distribution of acoustic pressure is as much as 48% distorted by a wall at a distance of two shell radii but remains almost undistorted by a wall at a distance of ten shell radii. Figures 4; references 5 Russian.
[65-2415]

UDC 539.3

VIBRATIONS OF SHELLS OF REVOLUTION DISCRETELY REINFORCED WITH LONGITUDINAL STIFFENERS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, 1980 pp 95-97 manuscript received 7 Feb 79

PISANKO, A. N., Dnepropetrovsk Civil Engineering Institute

[Abstract] The frequencies and modes of the quasi-transverse natural vibrations of shells of revolution in general are determined on the basis of the theory of perturbations. The pertinent equations of natural modes and boundary conditions are written in operator form. The findings are compared with experimental data on 8 parabolic shells of revolution. The computed frequencies are found to be in all cases lower than their experimental counterparts so far as the upper part of the spectrum is concerned; this is apparently due to the inapplicability of equations of the theory of quasi-transverse vibrations to the description of modes with short wavelengths. The derived approximate analytical solutions of the problem of the natural vibrations of orthotropic shells of revolution assure effective utilization of the asymptotic method for the dynamic calculation of stringer shells. Figure 1; references 7: 5 Russian, 2 Western.
[71-1386]

UDC 539.3+62.50

APPLICATION OF MATHEMATICAL PROGRAMMING TO THE PROBLEM OF THE OPTIMAL CONTROL OF PLATE AND SHELL VIBRATIONS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, 1980 pp 98-100 manuscript received 7 Feb 79

KARNOVSKIY, I. A., LANDA, M. SH. and POCHTMAN, YU. M., Dnepropetrovsk Civil Engineering Institute

[Abstract] Programmed optimally rapid control of the vibrations of a broad class of plates and shells with the object of eliminating such undesirable effects as flutter, resonance, and others that arise during transient processes is considered. The problem is reduced to a corresponding problem of mathematical programming for a system (flexible plate, shell), whose state is described by a system of nonlinear equations with corresponding boundary conditions. The optimal control problem is then so formulated as to find the control action reducing the vibrations of the shell or plate to a specified level within minimum possible time. Matrix equations representing the difference analogues of the input equations of motion are derived and solved successively at each time step. A sample problem pertaining to a rectangular steel plate under a harmonic load is analyzed, and it is found that the derived control actions assure maintaining the level of vibrations within specified limits. Figures 3; references 9 Russian.
[71-1386]

UDC 539.4

THREE-DIMENSIONAL WAVE PROCESSES IN COMPOSITE HOLLOW CYLINDERS INTERACTING WITH THE AMBIENT MEDIUM

Kiev PROBLEMY PROCHNOSTI in Russian No 3, 1980 pp 101-104, 114 manuscript received 2 Jul 79

BABICH, YU. N., Kiev, Institute of Strength Problems, UkrSSR Academy of Sciences

[Abstract] Composite thickwalled cylinders in an acoustic medium were studied for response to a plane wave of a length approximately equal to the cylinder wall thickness. The dynamics, transmission and reflection of elastic waves in the materials of cylinders of finite length during the initial instants were investigated when interaction with the ambient medium may be

governed by the plane reflection hypothesis. The stressed and strained state arising in the neighborhood of contact between structural elements made of different materials was analyzed. Calculations based on equations of elasticity theory showed that short waves of a length commensurate with cylinder wall thickness generate tensile radial stresses and high-frequency vibrations of the cylinder wall. For the case of two-layer cylinders the tensile stresses decrease if the external layer of the cylinder is of a more compact material than the internal layer. These findings are of interest for designs based on brittle materials (concrete, pyroceramics) with low resistance to tensile stresses. Figures 6; references 12: 10 Russian, 2 Western.

[71-1386]

UDC 539.3:534.1

EFFECT OF AN EXPLOSION WAVE ON A PLATE

Kiev PROBLEMY PROCHNOSTI in Russian No 3, 1980 pp 105-107 manuscript received 7 Aug 79

YAKUPOV, R. G., Ufa Aviation Institute

[Abstract] The propagation of a plastic explosion wave detonated in a compact medium (soil) at some distance from an overlying rectangular plate of uniform thickness is investigated. The shock wavefront is parallel to the plate surface and at some time instant the wave strikes the plate and rebounds from it. The flexures of the plate under the action of the explosion wave are considered. Corresponding equations of one-dimensional motion and continuity of the medium are written in Lagrange variables. It is shown that the damping effect of the medium (soil) causes the motion of the plate to be aperiodic. Small elastic displacements of the plate due to collision with the incident wave are determined. A simplified formula based on determining the wave pressure on the plate for an absolutely immobile obstacle is presented; as an alternative, the parameters of the reflected wave may be derived from approximate formulas for a short interval of time within which the motion of the plate occurs in the direction of propagation of the incident wave. Figures 2; references 6 Russian.

[71-1386]

UDC 539.374

ANALYSIS OF THE ELASTOPLASTIC STATE OF A SPHERICAL SHELL WITH A NOZZLE, WITH ALLOWANCE FOR COMPRESSIBILITY OF THE MATERIAL

Kiev PROBLEMY PROCHNOSTI in Russian No 3, 1980 pp 108-111 manuscript received 12 Jul 78

BANDIN, O. L., CHIZHEVSKIY, A. N. and SHARSHUKOV, G. K., Moscow

[Abstract] The elastoplastic state of a spherical shell with a nozzle is analyzed on the basis of the theory of small elastoplastic deformations by replacing the hypothesis of the elastic change in volume with the assumption that the coefficient of transverse deformation is an autonomous function of strain rate that is independent of the type of stressed state. Corresponding boundary and contact conditions are added to the pertinent equilibrium conditions. Theoretical calculations are found to be in agreement with the experimental findings for meridional and annular deformations and stresses in the outer and inner surfaces of a spherical shell with a nozzle. It is thus shown on the basis of a theoretical analysis of the elastoplastic state with allowance for compressibility of the material that substantiated calculations of the design elements of pressurized vessels can be performed without resorting to expensive and lengthy field tests. Figures 3; references 6 Russian. [71-1386]

UDC 621.165-226.001.24

APPLICATION OF THE SUPERELEMENT METHOD TO THE DESIGN OF STEAM-TURBINE NOZZLE DIAPHRAGMS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, 1980 pp 112-114 manuscript received 15 Jan 79

BILAN, V. N., Sverdlovsk, Ural Turbomotor Plant

[Abstract] The stress-strain condition of a steam-turbine diaphragm is analyzed, considering the split diaphragm as a system of a rim and a body connected by 30-40 identical radially positioned blades. The problem is solved with the aid of the finite element method by partitioning the rim and body into curvilinear elements and the blades into rod-type finite elements. To assure satisfactory accuracy, each blade is partitioned into 15-20 finite elements and described by 100-150 nodal parameters. Allowance for the topology of the system results in simplifying the problem: each blade is linked to the rim and body at only two nodes, located at its ends. All nodal

parameters in the internal nodes of the blade can be disregarded on the basis of the superelement method. It is shown that the superelement method reduces the length and labor requirement of calculations as performed on a YaB-1022 computer in FORTRAN: then the solution time of the entire problem is 5 min. The agreement between theory and experiment is improved if allowance is made for the elasticity of the rim-blade-body weldment, since then calculations of maximum flexure are more accurate. References 4 Russian.
[71-1386]

UDC 539.4

INVESTIGATION OF STRESSED STATE OF THE TOOL IN THREE-DIMENSIONAL SIZING OF HOLLOW CONICAL WORKPIECES

Kiev PROBLEMY PROCHNOSTI in Russian No 3, 1980 pp 115-117 manuscript received 3 May 79

YELISTRATOV, V. I. and SIDLYAR, M. M., Kiev

[Abstract] Tools used for three-dimensional sizing of conical nonferrous-metal products with rounded tips are subject to forces of as much as 230 metric tons and undergo stresses reaching 600 kg/mm^2 . In this connection, the stresses arising in such tools were analyzed on an axisymmetric vessel (die) consisting of a conical part and a spherical bottom, partially filled with a viscous medium (as a model of a viscoplastic body). An axisymmetric punch of the same shape is plunged at a fixed rate into that vessel (die), thus forcing the medium to flow in the gap between the punch and the die. Differential equations of the motion of the viscous fluid in spherical coordinates are used to analyze the flow in this problem from the standpoint of the thin-layer theory. A corresponding formula for stress distribution in the tool during the volumetric calibration of various types of conical products with rounded tips is derived. The theoretical findings are in agreement with experimental findings on models of epoxy resin polymerized with maleic and phthalemaleic anhydrides and investigated by the polarization-optics method. Figures 3.
[71-1386]

UDC 539.3

SHOCKWAVE INTERACTIONS IN A HARDENING ELASTOPLASTIC MEDIUM

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 127-134 manuscript received 24 Nov 78

BASKAKOV, V. A., Voronezh

[Abstract] The nature and pattern of the deformation of a linearly hardening elastoplastic material on the trailing edges of interacting shockwaves is investigated. Self-similar elastic and elastoplastic solutions of the problem are constructed in two-dimensional form, assuming the presence of kinematic and isotropic hardening mechanisms and conditionally identifying the lines of separation between the regions of elastic and plastic deformation of the material. Boundary conditions for the solution of a quasi-linear system of differential equations in dissipative regions are specified for these lines of separation. The effect of the hardening parameter on the qualitative side of the wave interaction is considered. The principal formulas are analyzed with the aid of a computer; specific numerical results are obtained. Figures 3; references 7 Russian.

[62-1386]

UDC 678.632+620.178.7

A STUDY OF THE PROPAGATION OF SHOCKWAVES IN CELLULAR POLYSTYRENE

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 140-144 manuscript received 10 Nov 78

BODRENSKO, S. I., KRYSANOV, YU. A. and NOVIKOV, S. A., Moscow

[Abstract] The structure and parameters of the compressive shock wave (pressure, wave velocity, mass velocity) during impact loading of specimens of cellular polystyrene are investigated. The specimens, with a rated density ranging from 100 to 580 kg/m³, were impact-loaded with a hammer having an initial velocity ranging from 40 to 90 m/sec. The propagation of a system of two compression waves--the first shock wave, exerting a uniform pressure and having a fixed velocity, and the corollary plastic-compression wave with time-dependent parameters--was investigated with the aid of a pressure-sensitive detector and a capacitive pickup. Analysis of the findings showed that the relationship between the parameters of the first and second shock waves and the speed of sound in foam polystyrene, on the one hand, and the relative density of the polystyrene, on the other, is best described by power

functions. Further, the existence of two different yield points in foam polystyrene under such loading was established. The velocity of the first shock wave, which is uniform over the depth of the specimen, was found to be one-third to one-half as high as the propagation rate of longitudinal vibrations determined by the ultrasonic method. Figures 4; references 18: 13 Russian, 5 Western.
[62-1386]

UDC 539.374

PROPAGATION OF SMALL PERTURBATIONS IN A PLASTIC MEDIUM, AND SLIP LINES

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 6, 1979 pp 158-163 manuscript received 22 May 79

ROMENSKY, YE. I., Novosibirsk

[Abstract] Dynamic equations of an isotropic elastoplastic medium in a rectangular cartesian coordinate system are used to investigate surfaces describing the propagation of small-perturbation waves in a plastic medium. The equation of characteristic normals to the coordinate system is derived and used to represent the propagation of acoustic waves. The corresponding acoustic matrix (which determines three waves: one quasilongitudinal wave and two quasitranverse waves) is used to describe the surfaces of wave propagation. For the system of differential equations of the plastic medium in question it turns out that the acoustic matrix can degenerate at certain surfaces. This means that for some surfaces the velocity of one quasitranverse wave (shear wave) is zero. For the cases of the plane strained state and the plane stressed state these surfaces coincide with the slip surfaces of the classical theory of plasticity. References 5: 4 Russian, 1 Western.
[62-1386]

TESTING AND MATERIALS

UDC 681.785.554

THE DFS-40 FORTY-CHANNEL VACUUM QUANTOMETER

Leningrad OPTIKO-MECHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 11-13 manuscript received 16 Aug 78

ARKHPOVA, V. I., BEL'CHIKOV, Z. M., VOROB'EVCHIK, V. M., PODMOSHENSKAYA, S. V., FRIDMAN, M. G. and FROLOVA, R. N.

[Abstract] The Leningrad-Optical Mechanical Union has developed a new quantometer, designed for analysis of complex signals. The device includes the analytic capabilities of the DFS-36 and DFS-41 quantometers. It is a system of apparatus consisting of a 40-channel vacuum polychromator with a broad spectral range and great dispersion, three sources of excitation of spectra with three stages for specimens, an electronic recording device and a digital computer with output printer. A photograph of the equipment system is presented. The spectral range of the installation is 170-350 nm, dispersion 0.27-0.36 nm/mm. The quantometer can be tuned to analyze 40 elements in melts of 12 different types, including most important alloying elements and impurities, including sulfur, phosphorus and carbon. The DFS-40 is designed for large metallurgical and machine building enterprises and scientific research institutes with a complex program of analysis and large volume of analytic work. Figures 2; references 2 Russian.

[74-6508]

UDC 535.854.001.5:533.6.071

HOLOGRAPHIC INTERFEROMETER FOR TESTING THE DEFORMATION OF LENSES

Leningrad OPTIKO-MECHANICHESKAYA PROMYSHLENOST' in Russian No 1, 1980
pp 17-20 manuscript received 9 Aug 78

DUKHOPEL, I. I. and PEDINA, L. G.

[Abstract] A brief description is presented of the optical system and results of experimental testing of a holographic interferometer allowing testing of defects in the assembly of large compound lenses with any surface shape. It is based on a 4-mirror interferometer designed for testing of the correctness of the shape of spherical surfaces. The interference picture observed at the output of the instrument contains information concerning the location, magnitude and nature of changes in the wave front occurring after the lenses were placed in their mount. Analysis of the system developed shows that to assure high accuracy and convenience of operation, several changes must be made. These include slight rearrangement of mirrors, assurance of single-mode radiation of the laser which forms the light source and utilization of a laser with continuous radiation or a high pulse repetition frequency, since the device is used in real time. Figures 2; references 6 Russian.

[74-6508]

UDC 621.923:666.1.053

INFLUENCE OF BINDER COMPONENTS ON THE PROPERTIES OF A DIAMOND TOOL

Leningrad OPTIKO-MECHANICHESKAYA PROMYSHLENOST' in Russian No 1, 1980 pp 23-25 manuscript received 28 Dec 78

VORONTSOVA, N. M. and SHIRYAYEVA, M. P.

[Abstract] The influence of the content of dibutyl phthalate plasticizer on diamond tools based on epoxy binder designed for polishing of glass is studied. The results indicate that the hardness of specimens with 10% dibutyl phthalate binder averages 30% higher than the hardness of "pure" binder, and varies linearly with the content of dibutyl phthalate. A variation of the content of plasticizer by a factor of 4 changes the hardness of the binder-diamond layer by a factor of approximately 2. Figures 3; references 1 Russian.

[74-6508]

UDC 666.1.056:535.345.67

PRODUCTION OF STABLE NARROW-BAND FILTERS ON LARGE-DIAMETER SPECIMENS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 28-30 manuscript received 28 Dec 78

IVANOVA, L. A. and RUDINA, O. G.

[Abstract] A study is presented of the topography of coatings produced by the method of cathode sputtering, and means are sought for improvement of uniformity of such coatings. The object of study was a narrow-band filter, a 23-layer structure of alternating layers of titanium oxide and silicon dioxide with a separating $\lambda/2$ layer of SiO_2 for the visible area of the spectrum. During application, the substrate was rotated at 60 rpm around an axis passing through the center of the substrate and the cathode. The primary source of radial nonuniformity is to be found in the finite dimensions of the cathodes and the cosine law of distribution of the substance applied. The uniformity of coating is determined primarily by the edge effect of the cathode and the temperature gradient across the surface of the specimen, as long as pressure is constant. Variations in coating thickness resulting from this edge effect do not exceed 0.4% at the half diameter point. Uniform heating of the part can be achieved over at least half its diameter. Specimens 80 mm in diameter were produced with stable narrow-band filtration characteristics with a half width of 30 Å and a transmission of 65% and good usage characteristics. Figures 2; references 6 Russian.

[74-6508]

UDC 535.231.6-535.211

PHOTOACOUSTICAL METHOD OF RECORDING THE ENERGY OF PULSED RADIATIONS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 37-39 manuscript received 24 Jan 79

ONOKHOV, A. P., RAZUMOVA, T. K. and STAROBOGATOV, I. O.

[Abstract] Results are presented from studies of the characteristics of the photoacoustical method of measurement of energy. The device used included a cuvette with a liquid which absorbed radiation, a piezoceramic transducer with its electrodes attached to the input of an electronic amplifier from which the signal was sent to an oscilloscope, the screen of which was used to measure the amplitude of the transducer output signal. Photoacoustical measurement of energy can be used for measurement of pulsed

optical radiation with pulse length in the microsecond range. The device studied has comparatively high sensitivity and spectral non-selectivity, ranging from the ultraviolet through the infrared portions of the spectrum. Figure 1; references 8: 6 Russian, 2 Western.
[74-6508]

UDC 681.407.772.99.535.313.2

A SIMULATOR OF THE MAIN MIRROR OF A TELESCOPE BASED ON A SYNTHESIZED HOLOGRAM

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 39-41 manuscript received 28 Mar 79

LARIONOV, N. P., LUKIN, A. V. and RAFIKOV, R. A.

[Abstract] A study is made of the possibility of certification of the hardware used in the manufacture of astronomical telescope optics by the use of a synthesized hologram to simulate an "ideal" optical element, particularly the main mirror of a large telescope. The synthesized hologram can act either as a model of aberrations of perpendiculars to the surface, or as a model of aberrations of rays reflected from the surface when it is illuminated from a selected point on the axis. The principles of synthesis and testing of holograms, as well as the method of adjustment of the testing system based on the use of these holograms assures high accuracy of manufacture and utilization of the simulators for practically any shape of main mirror surface. Hartmann diagrams produced with a hologram simulator and time-average interferograms are presented. Figures 2; references 8: 6 Russian, 2 Western.
[74-6508]

UDC 535.361

THE SCATTERING CHARACTERISTICS OF METAL SURFACES WITH REGULAR AND IRREGULAR STRUCTURE AT A WAVELENGTH OF 10.6 μm

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 1, 1980 pp 43-46 manuscript received 22 Feb 79

ANDRONOV, V. P., BRONNIKOV, V. I., LIBIK, L. P. and SAVEL'EVA, V. P.

[Abstract] A study is made of the scattering indices of rough surfaces of metal specimens, as well as reflectors with periodic structural surface, at a wavelength of 10.6 μm . The scattering indices were measured at various beam incidence angles at intervals of 2.5°. The experimental data indicate that reflectors from rough surfaces produced by sand blasting can be successfully used at 10.6 μm wavelength to produce a broad and uniform scattering index changing little with various angles of incidence of the beam. Figures 4; references 5 Russian.

[74-6508]

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